Fall 2014
SEI Research Review
Behavior Based Analysis and Detection of Mobile Malware

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Project Description

Develop a fully automated behavior-based analysis approach capable of accurate suspicion assessment of software for mobile devices.

Expected Outcomes

- Behavior characteristics usable in assessing suspicion
- Efficient data collection techniques
- Automated app analysis with user interaction
- Suspicion assessment prototype for real devices

Impact for the DoD: identify potential malware early enough to avoid potential damage to the device. Provide fast accurate suspicion assessment of an app to an analyst

Behavior Characteristics

Identified various behaviors:

- Thread creation
- Accessing system data with potential PII
- Ingoing and outgoing SMS
- TCP connections
- Privilege escalation
- Device root

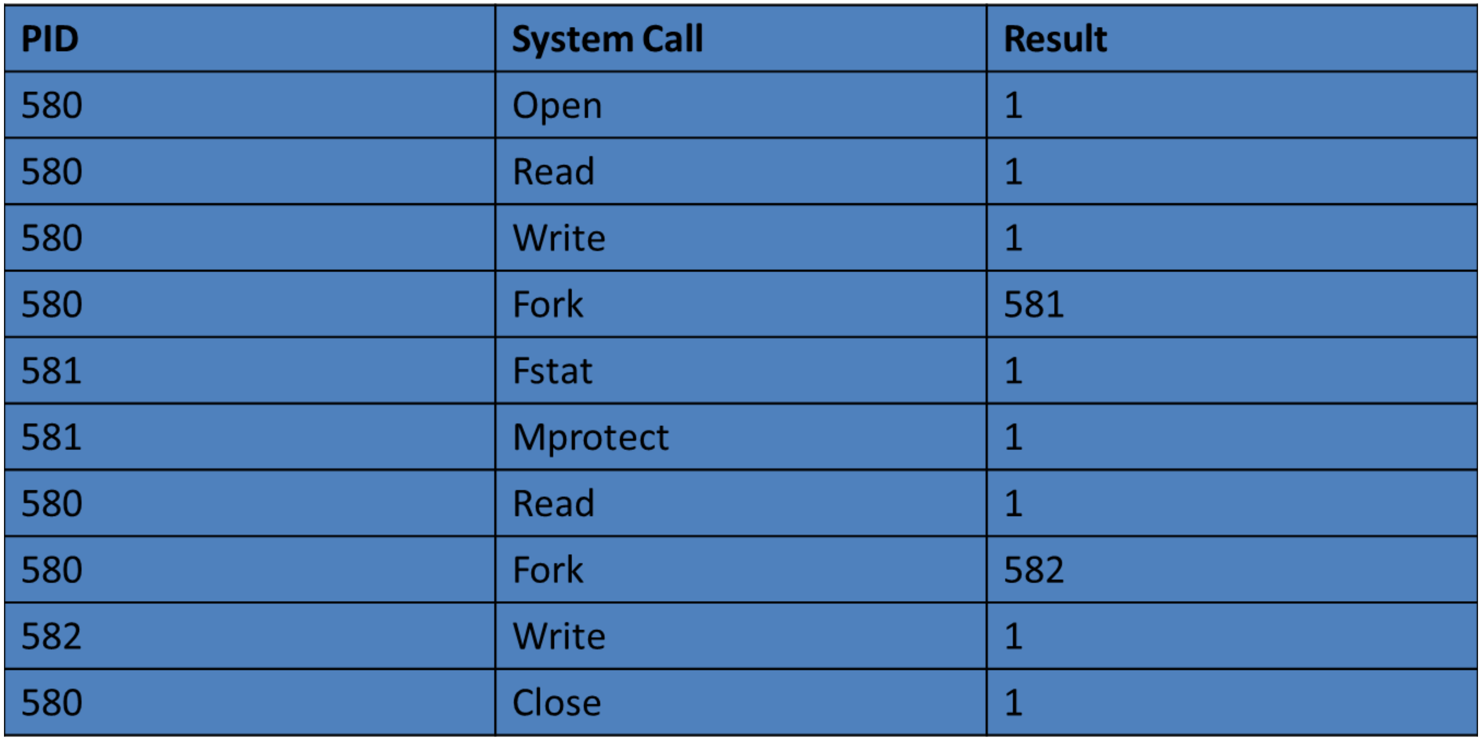
Most found in strace, logcat, and network data

Mostly occurs within a few seconds of main activity running

Analysis Methodology - Approach

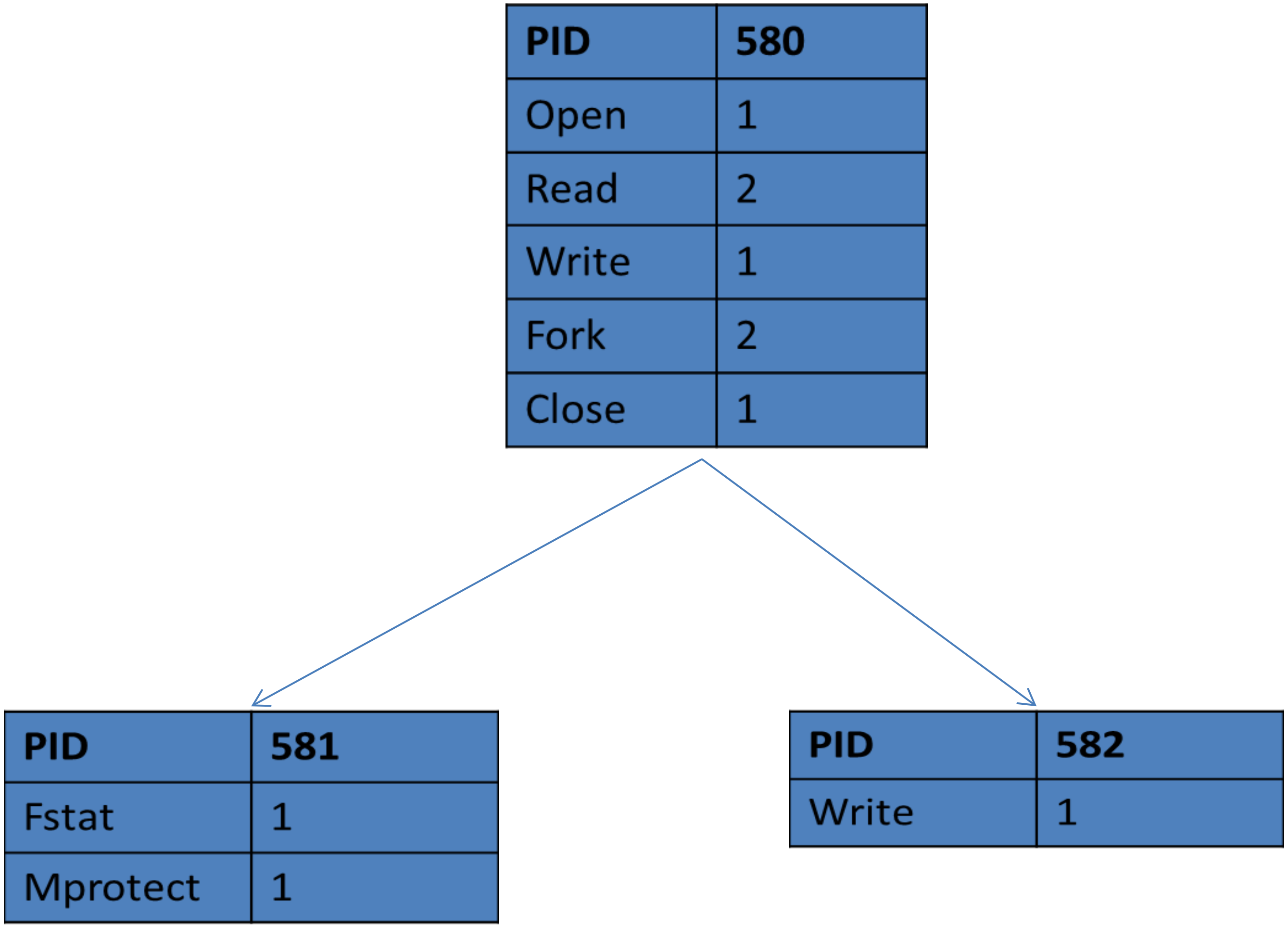
- Strace Android APK
- Convert strace to graph
- Apply graph kernel for similarity computation
- Feed similarity to SVM fro classification

Analysis Methodology – Strace Sample



PID	System Call	Result
580	Open	1
580	Read	1
580	Write	1
580	Fork	581
581	Fstat	1
581	Mprotect	1
580	Read	1
580	Fork	582
582	Write	1
580	Close	1

Analysis Methodology – Malware infection tree

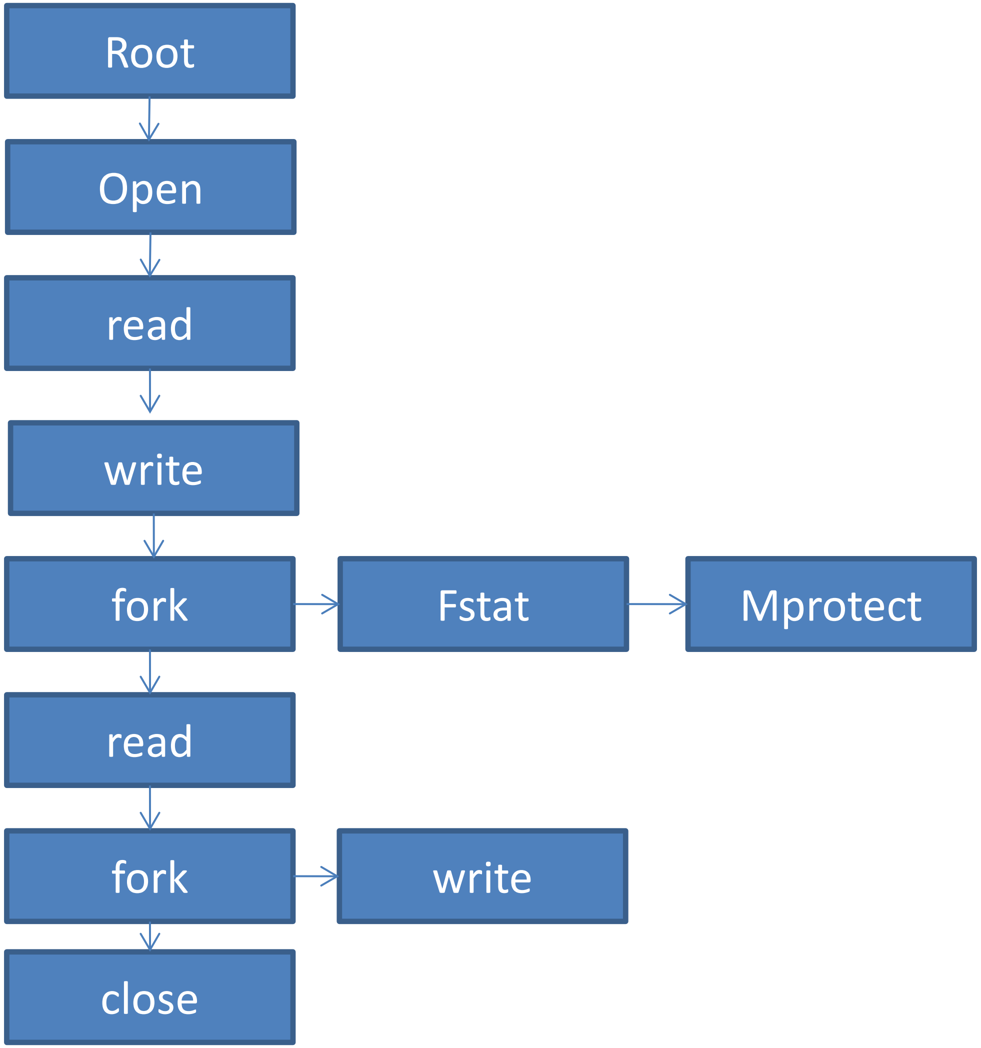


PID	580
Open	1
Read	2
Write	1
Fork	2
Close	1

PID	581
Fstat	1
Mprotect	1

PID	582
Write	1

Analysis Methodology – Ordered System Call Graph



Root

Open

read

write

fork

Fstat

Mprotect

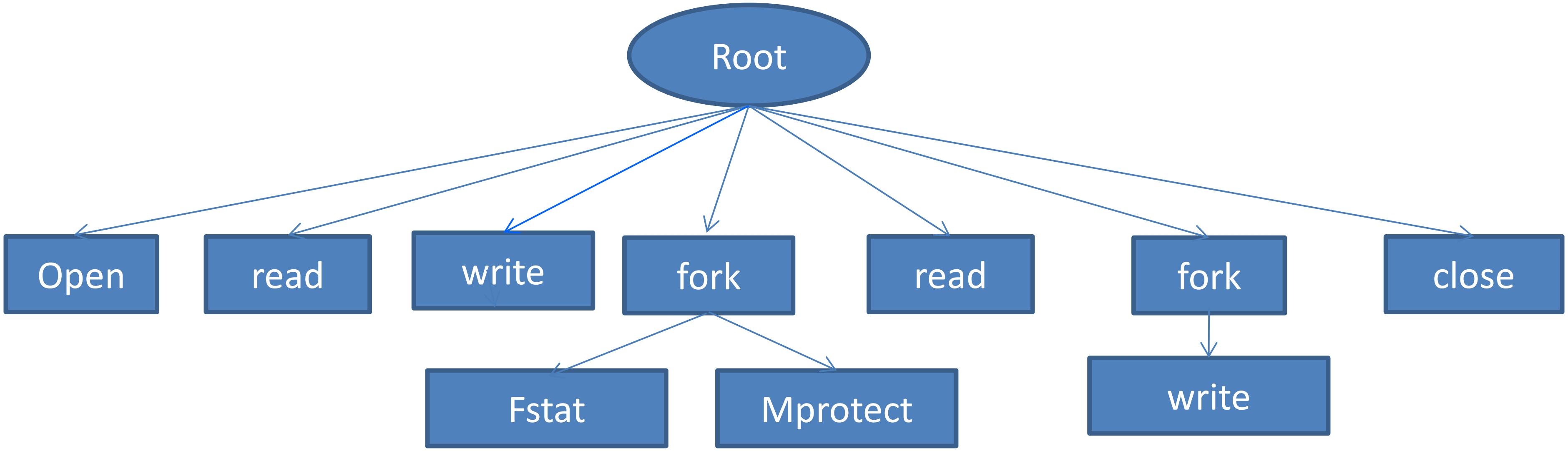
read

fork

write

close

Analysis Methodology – Unordered System Call Graph



Analysis Framework - 1

Two versions

1. analyze Android apps with interaction
2. and without interaction

Both run in Android SDK emulator on a linux VM.

Without interaction: runs the main activity of an app and collects the strace for 3 minutes

With interaction:

- leverage AppsPlayground (William Enck NCSU) for interaction
- attempt to run each app until all activities visited
- collect strace, logcat, network information, apk and signature data
- can run up to 30 minutes, average around 4 minutes to complete all activities

Analysis Framework - 2

- web based GUI created, accessible via website for public use.

- currently have 13K known malicious and 9K known benign android apps.

- all benign apps downloaded from Google Play

- Current analysis results are positive using malware infection trees.

  - with no interaction:

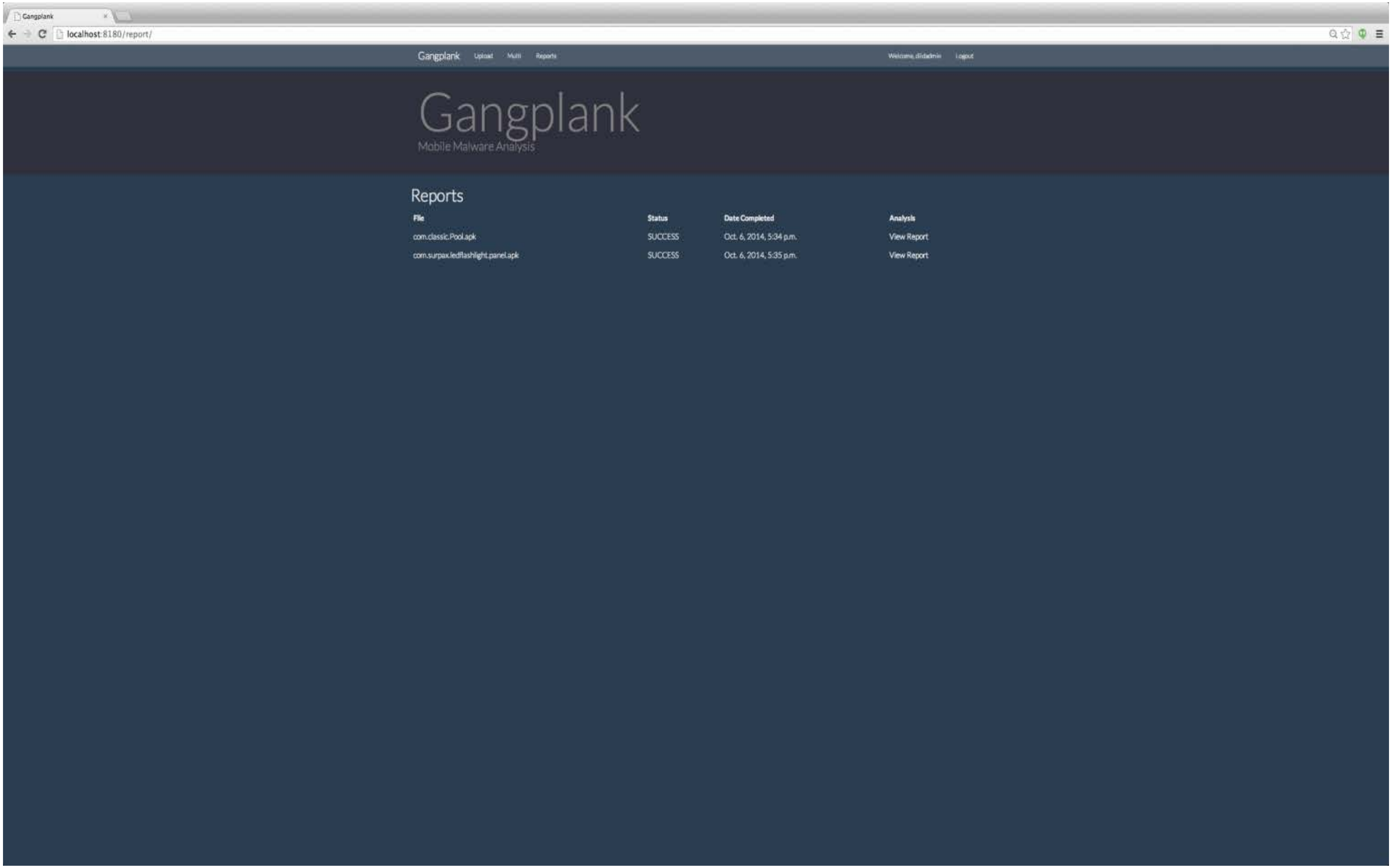
    -11800 malicious and 7729 benign android app samples (2009-2014)

    -27dimension feature vector per node using SVM

    -94% detection accuracy, 6.97%FN, 7.57%FP

      - unordered neighboring combined with intersection kernel

- machine learning done by Dr. Cavazos's group in Udel.



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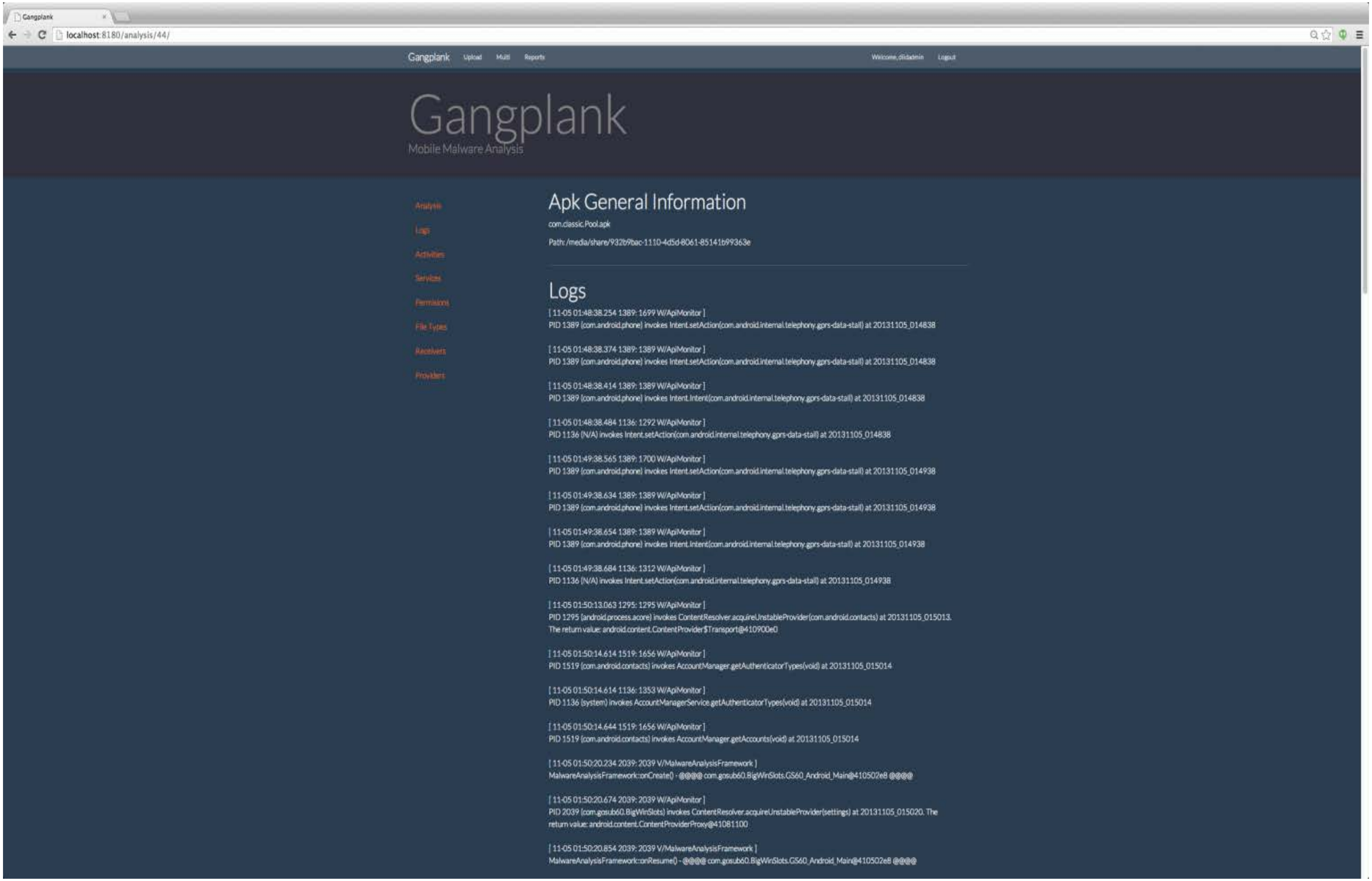
Mobile Malware Analysis

Reports

File	Status	Date Completed	Analysis
com.classic.Pool.apk	SUCCESS	Oct. 6, 2014, 5:34 p.m.	View Report
com.surpax.ledflashlight.panel.apk	SUCCESS	Oct. 6, 2014, 5:35 p.m.	View Report



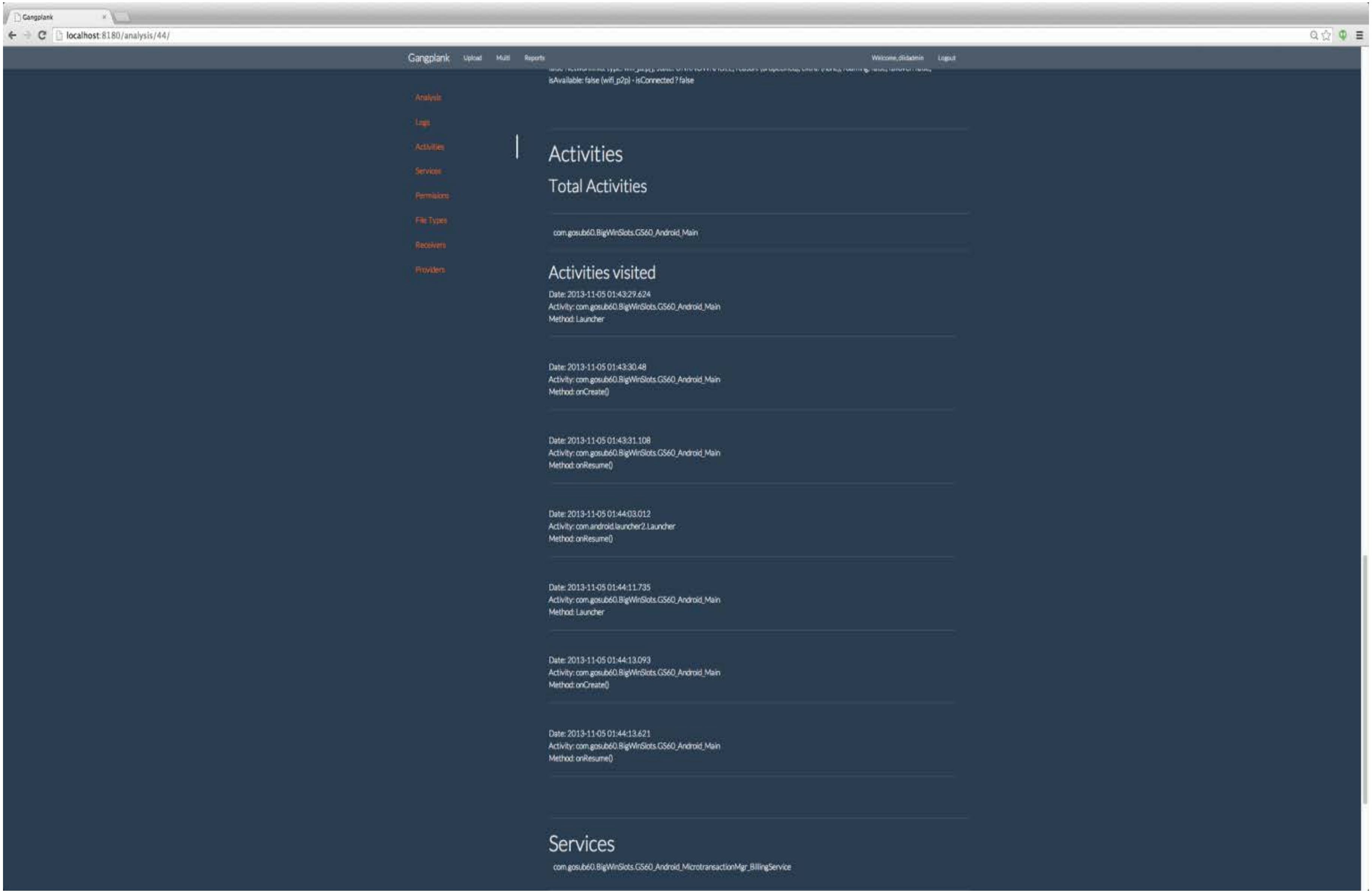
Apk General Information

com.classic.Pool.apk

Path: /media/share/932b9bac-1110-4d5d-8061-85141b99363e

Logs

```
[ 11-05 01:48:38.254 1389: 1699 W/ApiMonitor ]
PID 1389 (com.android.phone) invokes Intent.setAction(com.android.internal.telephony.gprs-data-stall) at 20131105_014838

[ 11-05 01:48:38.374 1389: 1389 W/ApiMonitor ]
PID 1389 (com.android.phone) invokes Intent.setAction(com.android.internal.telephony.gprs-data-stall) at 20131105_014838

[ 11-05 01:48:38.414 1389: 1389 W/ApiMonitor ]
PID 1389 (com.android.phone) invokes Intent.Intent(com.android.internal.telephony.gprs-data-stall) at 20131105_014838

[ 11-05 01:48:38.484 1136: 1292 W/ApiMonitor ]
PID 1136 (N/A) invokes Intent.setAction(com.android.internal.telephony.gprs-data-stall) at 20131105_014838

[ 11-05 01:49:38.565 1389: 1700 W/ApiMonitor ]
PID 1389 (com.android.phone) invokes Intent.setAction(com.android.internal.telephony.gprs-data-stall) at 20131105_014938

[ 11-05 01:49:38.634 1389: 1389 W/ApiMonitor ]
PID 1389 (com.android.phone) invokes Intent.setAction(com.android.internal.telephony.gprs-data-stall) at 20131105_014938

[ 11-05 01:49:38.654 1389: 1389 W/ApiMonitor ]
PID 1389 (com.android.phone) invokes Intent.Intent(com.android.internal.telephony.gprs-data-stall) at 20131105_014938

[ 11-05 01:49:38.684 1136: 1312 W/ApiMonitor ]
PID 1136 (N/A) invokes Intent.setAction(com.android.internal.telephony.gprs-data-stall) at 20131105_014938

[ 11-05 01:50:13.063 1295: 1295 W/ApiMonitor ]
PID 1295 (android.process.acore) invokes ContentResolver.acquireUnstableProvider(com.android.contacts) at 20131105_015013.
The return value: android.content.ContentProvider$Transport@410900e0

[ 11-05 01:50:14.614 1519: 1656 W/ApiMonitor ]
PID 1519 (com.android.contacts) invokes AccountManager.getAuthenticatorTypes(void) at 20131105_015014

[ 11-05 01:50:14.614 1136: 1353 W/ApiMonitor ]
PID 1136 (system) invokes AccountManagerService.getAuthenticatorTypes(void) at 20131105_015014

[ 11-05 01:50:14.644 1519: 1656 W/ApiMonitor ]
PID 1519 (com.android.contacts) invokes AccountManager.getAccounts(void) at 20131105_015014

[ 11-05 01:50:20.234 2039: 2039 V/MalwareAnalysisFramework ]
MalwareAnalysisFramework::onCreate() - @@@@ com.gosub60.BigWinSlots.GS60_Android_Main@410502e8 @@@@

[ 11-05 01:50:20.674 2039: 2039 W/ApiMonitor ]
PID 2039 (com.gosub60.BigWinSlots) invokes ContentResolver.acquireUnstableProvider(settings) at 20131105_015020. The
return value: android.content.ContentProviderProxy@41081100

[ 11-05 01:50:20.854 2039: 2039 V/MalwareAnalysisFramework ]
MalwareAnalysisFramework::onResume() - @@@@ com.gosub60.BigWinSlots.GS60_Android_Main@410502e8 @@@@
```



isAvailable: false (wifi_p2p) - isConnected ? false

Activities

Total Activities

com.gosub60.BigWinSlots.GS60_Android_Main

Activities visited

Date: 2013-11-05 01:43:29.624
Activity: com.gosub60.BigWinSlots.GS60_Android_Main
Method: Launcher

Date: 2013-11-05 01:43:30.48
Activity: com.gosub60.BigWinSlots.GS60_Android_Main
Method: onCreate()

Date: 2013-11-05 01:43:31.108
Activity: com.gosub60.BigWinSlots.GS60_Android_Main
Method: onResume()

Date: 2013-11-05 01:44:03.012
Activity: com.android.launcher2.Launcher
Method: onResume()

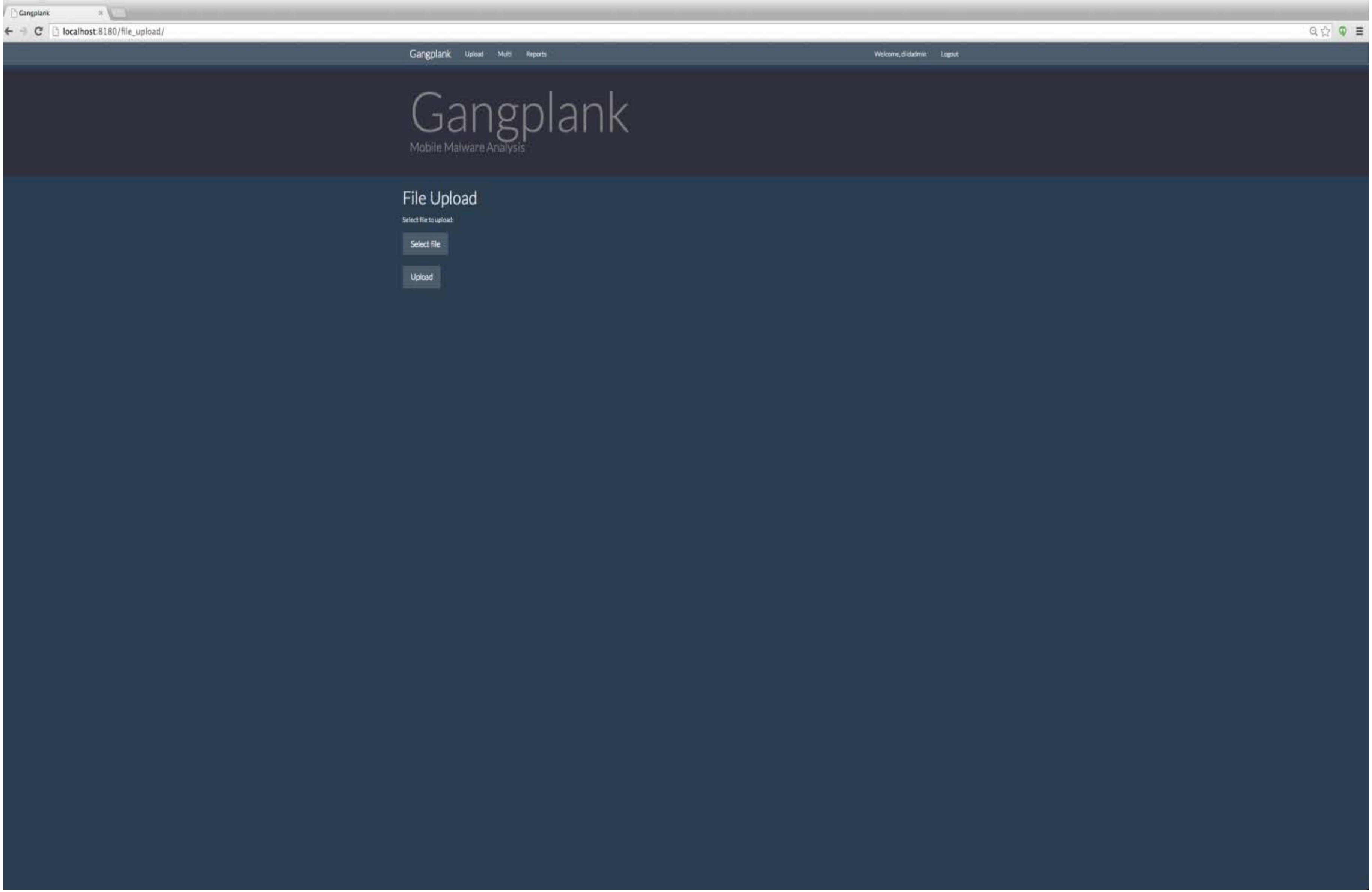
Date: 2013-11-05 01:44:11.735
Activity: com.gosub60.BigWinSlots.GS60_Android_Main
Method: Launcher

Date: 2013-11-05 01:44:13.093
Activity: com.gosub60.BigWinSlots.GS60_Android_Main
Method: onCreate()

Date: 2013-11-05 01:44:13.621
Activity: com.gosub60.BigWinSlots.GS60_Android_Main
Method: onResume()

Services

com.gosub60.BigWinSlots.GS60_Android_MicrotransactionMgr_BillingService



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Mobile Malware Analysis

File Upload

Select file to upload:

Final Thoughts

- Analysis framework accessible via web gui
- 94% detection accuracy based on strace file analysis
- better detection than most major anti-malware engines
- Our accuracy is far better than other anti-malware with newer samples
- Majority of malicious activity occurs in first 2 seconds of execution
- Should continue to improve features to reduce FN and FP
- Paper being submitted to IEEE Security and Privacy

Interested in knowing more???

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